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A Study on Geotechnical Characteristics of Compacted Shredded Tyre-Soil Mixes

Nisha Kumari Singh, Taba Punung, Vanlalhmuaka, Tage Moda, J.H Pauminsiama, Ajanta Kalita

North Eastern Regional Institute of Science and Technology (NERIST), Nirjuli, Arunachal Pradesh 791109, India
Corresponding author email Id: ajanta.pari@gmail.com
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Abstract

This paper deals to enhance the properties of the soil using the easily available waste product. Stabilisation of locally available red soil using a waste product i.e. the shredded tyre chips are investigated and CBR test followed by the compaction test is conducted to study the fundamental physical properties of soil–rubber interaction. The waste tyres were added in different proportion of 5%, 10%, 15%, and 20% by weight and are mixed with the soil before carrying out various tests. Results from the study suggested that with the addition of 15% shredder tyre chips cause the CBR value increase from 4.66 to 7.03 in un-soaked condition and 2.7959 to 4.2889 in soaked condition. This confirm that shredded tyres chips are enable of increasing the strength of the soil and hence can be used for soil stabilisation.

Keywords: Geotechnical Characteristics, Shredded Tyre-Soil Mixes, Red soil, Soil Strength, Shear tests

Research Article

1. Introduction

Large number of huge engineering structures are predominantly constructed on the soil. It is very necessary for the soil to have enough strength to resist as well as retain the load of the structures. In many areas, the buildings and the other structure go differential settlement under some sudden load or may be due to its own load. Sometimes the structures get fully collapse under the seismic load. If it is not possible for the soil in the particular area that have the required strength, then there is a need to increase the strength of the soil with the help of some additives or cost-effective product. In this view, items such as thermo-gelation biopolymers (gellan gum, agar gum), lime, cement, epoxy, acrylamide, phenoplasts, polyurethane, glass water, bitumen, cement residues, and fly-ash and shredded tyre chips etc are widely studied and used [1-6]. Hydrate complexes etc obtained by means of silica sol, foam concrete and phosphates are also greatly in study [7] The disposal of used tyres is a major environmental problem causing hazards such as breeding ground for mosquitoes, chances of uncontrolled fire and prone to contaminate the soil. So, following the principle waste to wealth, studies with this waste product as a soil reinforcement agent to increase the soil property has great importance. Tyres are made up of rubber possessing the tensile strength that increases its strength when used in soil. Eldin and Senouci, [7] conducted a field trial to investigate the influence of tyre chips size, placement methods and soil cap thickness on road performance by varying tyre chips size ranging from 2” to 8”. Ghazavi and Sakhi [8], conducted direct shear tests to enquire the influence of tyre chip size maximum of 10 mm on shear strength parameters of rubber hose grain- sand mixtures as well as evaluate the feasibility of

this mixtures as a light weight backfill material in geotechnical application. The findings of the study enlighten that the shear resistance of the sand rubber mixtures have non-linear trend with increase in rubber content; sand-rubber mixtures condensed initially which is higher than sand alone and then dilate under shear stress and the apparent cohesion appears and increases in the mixtures with introduction of rubber content. The compressive behaviour of sand using tyre mixture to conduct tri-axial test for the mechanical properties of pure tyre chips as well as sand-type chip mixture are investigated in detail [9,10]. The general stress strain curve for tyre chips is non-linear and finite element method was used for analysis deformation and stresses for tyre chips and soil. Ahmed [11] investigated the feasibility of using shredded tyre chip ranges from 12.5 mm 25 mm for soil mixtures as lightening geo material for highway embankments. Tatlisoz et al [12] investigated the effect of fines on mechanical properties of soil-tyre shred mixtures by conducting large scale direct shear and consolidometer tests on three types of soil namely clay, sand and sandy silt. Tyre chip mixtures have higher trength than sand alone, and the increase in strength is a function of tyre chip content and normal stress whereas the strength increases not realized for clay-tyre chip mix and soil-tyre chip mixtures do not undergo significant long-term deformation even in soaked [12,15-16].

Therefore, due to the versatility of the tasks, present work attempts to evaluate the properties of soil with the use of shredded tyres and compare it with soil properties without any mix.

2. Materials and Methodology

Soil was collected from the hill top of Doimukh village, Papumpare Arunachal Pradesh. It is then oven dried after breaking the lumps. Shredded rubber tyres of average size 5mm is obtained from the waste tyre of truck from the manufacturing factory located at A-Sector Naharlagun. Series of laboratory test is conducted to know the soil properties. It includes grain size analysis, liquid limit, plastic limit, plasticity index, specific gravity, moisture content, compaction test, and California Bearing Ratio test [13-14].

Figure 1.1 Waste Tyres

Figure 1.2 shredded Tyres

The compaction test was done with the varying proportion of tyre chips as nil, 5%, 10%, 15% and 20% along with soil content keeping total weight constant. Maximum dry density (MDD) and optimum moisture content (OMC) are done for analysing compaction according to standard method. MDD is a key parameter as out come of stabilization after compaction and before curing. OMC is also a vital parameter when soil stabilization is studied.

3. Observations and results

The fundamental properties of the considered soil are given below in the Table 1 where silt is dominated over sand and clay fraction.

Table 1.1 Properties of soil

Property	Value
Sand fraction (%)	9.8
Silt fraction (%)	76
Clay fraction	14.2
Specific gravity	2.66
Liquid limit (%)	42
Plastic limit (%)	28.35
Plasticity index (%)	13.65
Optimum moisture content (%)	15.39
Maximum Dry Density (g/cc)	1.79

Compaction test

The compaction test was done with the varying proportion of tyre chips. It was seen that the MDD and OMC both varies with the addition of tyre chips. The graph obtained for the varying proportion are shown in Fig 1.1. OMC of 14-16% was present at tyre chips of up to 10% and slightly decreased to 12-13% when tyre chips (%) was increased to 15-20% showing optimum OMC at 15% of tyre chips addition.

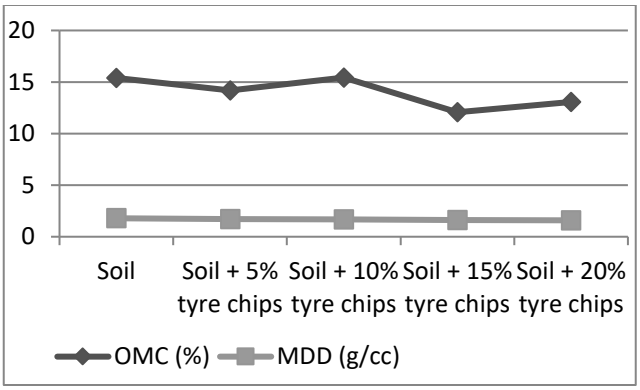

Figure 1.3 Variation of MDD and OMC with varying propertion of tyre chips

From the figure it can be seen that the increase in the addition of tyre chips decreases the MDD value towards higher end.

California Bearing Ratio test

To check the strength of the soil using tyre chips California Bearing Ratio test is conducted. CBR test both for soaked and unsoaked condition expressed that while in unsoaked condition it gives the higher value than in soaked condition.

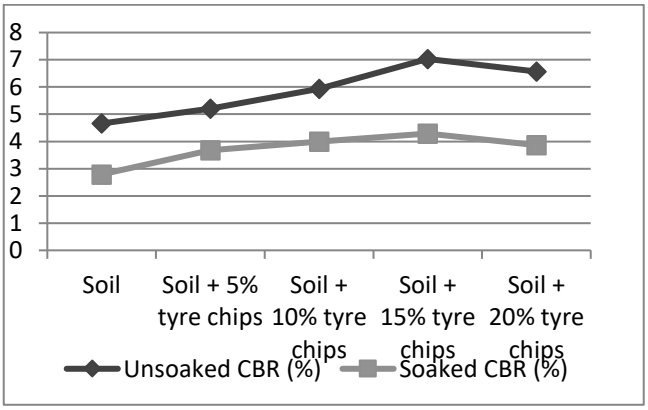

Figure 1.4 Variation of CBR value with the addition of tyre chips

Fig 1.2 shows the significant change in the CBR value being maximum at soil tyre combination at 15%. It is observed from the graph that with the addition of tyre chips there

is increase in the CRB value from 4.66 to 7.03 in unsoaked condition and from 2.79 to 4.29 in soaked condition.

Conclusion

It can be concluded that the addition of tyre chips in the soil increases its strength upto 50.8%. the tyre which has tensile srength when used with the soil also increase the strength of the soil. So for the construction of heavy structure on the weak soil the shredded tyre can be used to increase the bearing capacity of the soil.

Conflict of interest

The author declares no conflict of interest.

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